ATTACHMENT A

Remarks

Claims 1-3 and 7-10 have been rejected under 35 USC 102(b) as being "anticipated by" the newly cited Fork et al patent while claims 11-14, 16-18 and 20-22 have been rejected under 35 USC 103(a) as being unpatentable over the Fork et al patent. The independent claims have been amended to more clearly distinguish over the Fork et al patent and all of the claims presented are now believed to be patentable for the reasons set forth below.

By way of background, it is noted that the Fork et al reference and the present invention both deal with the modulation of transmitted light pulses. Light pulses are comprised of not just one wavelength, but rather a spectrum of wavelengths or frequencies. Thus, it takes an entire grouping of frequencies to make a single light pulse. The shorter the pulse, the broader the spectrum of light frequencies required to make up the pulse. Accordingly, a very, very, very short pulse (e.g., a pulse a femtosecond (10^{-15} second) in length) will have a relatively broad spectrum of light frequencies that make up the pulse itself. Unlike a continuous wave (infinitely long pulse) laser that has a very narrow spectral width (nearly a single wavelength), pulse sources generally produce light that is relatively broad in spectrum.

While the Examiner is probably quite familiar with these terms, it is believed to be helpful to consider some definitions here. For example, "phase velocity" is the speed at which any particular single wavelength of light will travel across some specified distance and through some specified material. Phase velocity is highly dependent on the refractive index of the material. "Group velocity" is the speed with which a pulse will travel across some specified distance and through some specified material. As indicated above, pulses are made of a grouping of frequencies, not just a single frequency, so that the speed with which all these frequencies travel in a group can loosely be called the group velocity. There are other factors that come into play in defining group velocity, but for the purposes here, the term can be understood as referring to the velocity of the pulse.

For reasons that need not be discussed here, materials that transmit light here are generally dispersive. This means that blue light will take longer to pass through something than red light. Accordingly, applying this to a pulse, which is comprised of a spectrum of light, the shorter wavelength frequencies (blue) will take longer to propagate through a material than the longer (red) wavelength frequencies. If a pulse is made up of some span of frequencies, then the shorter wavelength frequencies will take more time to get through the material than the longer wavelength frequencies, thereby causing the pulse to basically fall apart during propagation.

The Fork et al patent and the present invention are similar to the extent that both are concerned with the construction of an optical device with characteristics that are favorable to impart an optical change onto a propagating pulse or a single wavelength without introducing destructive dispersion (and possibly even correcting destructive dispersion). Both approaches use multilayer stacks of dielectric materials and similar methods of changing the optical properties of these dielectric materials are employed. However, there are important differences primarily in the construction of the respective devices and the intended objectives thereof.

Considering the latter point in more detail, the Fork et al patent deals primarily with adjusting the group and phase velocity of an optical pulse using spectrally-narrow transmission resonance regions produced as a result of the multilayer dielectric stack design. The entire device uses a small cavity with reflectors (mirrors) at each end. A multilayered stack is placed in the middle of the cavity that can be used to passively impart a particular group velocity to a pulse, or to actively be tuned to cause a specific change in the group velocity. Once a pulse is in the cavity, it continues to bounce back and forth in the cavity, passing through the multilayered stack of dielectric material in the center and collecting some amount of group velocity retardation during each pass. After some predetermined time or number of passes, the pulse is released through one of the mirrors at one end of the cavity and the pulse progresses on with some amount of accumulative group delay.

It is important to note that the multilayered stack in the middle of the Fork et al resonator comprises a periodic, repeating pattern of cells of dielectric materials each

with specific refractive indexes (one high, one low). This is shown for example in Figures 3A and 3B wherein, in Figure 3A, cells 11A, 11B, 11C, etc. are of the same thickness "a" and of the same refractive index n_1 and cells 12A, 12B, 12C, etc. are of the same thickness "b" and have the same refractive index n_2. In the embodiment of Figure 3B the cell 18A ... 18N each have the same cell thickness "d" and an index of refraction n(x) that varies across the thickness of the unit cell.

This repeating arrangement of layers or cells produces optical transmission resonances (perhaps best illustrated in Figures 11A and 11B) in a region where a pulse properly positioned in frequency can be transmitted with very little loss of reflection (the dotted lines in Figures 11A and 11B indicate transmission as opposed to reflection while solid lines indicate the amount of group delay available, it being noted that high amounts of group delay are available in regions where the transmission is equal to 1, and the resonance is most narrow).

A drawback to this approach is keeping the frequency spread of the pulse completely under one of these narrow transmission resonances. As discussed above, the shorter the pulse, the broader the frequency spread thereof. Therefore, very short pulses will have difficulty fitting under a very narrow transmission resonance such as produced by the method disclosed in the Fork et al patent.

In addition, this approach modulates group velocity by shifting the entire transmission functions such that the spectral spread of the pulse is moved from one transmission resonance to the neighboring transmission resonance that exhibits a different level of group velocity delay.

In general, the present invention deals primarily with adjusting the phase velocity of all frequencies within some spectral band while maintaining a constant group velocity using a spectrally-wide transmission region. The phase modulator of the invention does not use a resonating cavity with mirrors at each end as in the Fork et al patent. Moreover, while the active portion of the modulator is a multilayered stack similar to that used in the Fork et al patent, the stack is different from that of the patent in that it is constructed of multiple dielectric layers that are nonperiodic and nonrepeating in their layer thicknesses. Thus, while there may be some repeating layer thicknesses as

discussed in connection with the embodiments described at page 15 to 17 of the application, layers of different thicknesses are inserted in the stack so that the overall thickness pattern is nonperiodic and nonrepeating (see, e.g., Equation 7 which represents an exemplary 79 layer bandpass multilayer stack configuration).

The construction of the stack of the modulator of the present invention is optimally designed to produce a wide range of transmission (as opposed to the narrow transmission resonances in the Fork et al patent) and to provide a near linear phase change function across the transmission region (as opposed to the narrow region providing a high level of group velocity reduction in the Fork et al patent). By providing a region of linear phase change, the phase of all the frequency components comprising the pulse may be changed in phase simultaneously and may be changed by the same amount without affecting the pulse group velocity. Because the transmission region is broad, the phase may be adjusted in an analog fashion. This is obviously different from the abovementioned approach disclosed in the Fork et al patent of shifting from one transmission resonance to the neighboring transmission resonance, i.e., where the shift is an "all-or-nothing" shift.

The independent claims have been amended so as to reflect the differences discussed above. For example, claim 1 recites that the dielectric layers are of at least three different thicknesses arranged in an aperiodic thickness pattern such that the phase modulator exhibits a nonlinear phase modulation over a wide bandwidth. Claim 17 recites that the stack includes a plurality of alternating layers of different thicknesses and a plurality of further layers of at least one further thickness interspersed between these alternating layers while claim 22 recites that the dielectric layers comprise alternating layers of two different thicknesses as well as further interspersed layers of at least one further thickness so that the stack comprises an arrangement of the layers of thicknesses of an overall nonrepeating, aperiodic pattern. Claims 20 and 21 have been similarly amended and refer to both alternating layers and further layers of different thicknesses (relatively thin layers of AlAs in claim 20 and relatively thick layers of GaAs in claim 21) inserted or interspersed within the stack. It is respectfully submitted that all of these claims patentably define over the Fork et al patent which clearly does not

disclose these features and in which, as discussed above, the layer thicknesses are repeating and periodic in the case of Figure 3A and all of the same thickness in the case of Figure 3B. These differences in stack construction reflect the very important differences in purpose and operation discussed above and thus it is believed that the claims now presented are clearly all patentable over the Fork et al patent.

Allowance of the application in its present form is respectfully solicited.

END REMARKS